INTERNAL BUILDING PRESSURE APPARATUS AND METHOD

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FIELD OF THE INVENTION

This invention relates to an internal building pressure apparatus and method. In particular, in a building with walls and more than one floor, an internal building pressure apparatus includes at least one pressure sensor per floor so as to provide data for analysis and control of interior building pressure.

BACKGROUND OF THE INVENTION

The regulation and manipulation of building pressures is a complicated and difficult issue. The regulation of building pressures is not only difficult to accomplish but it is exceedingly difficult to accomplish when guided by prior art assumptions. Assumptions concerning building pressure regulation have been determined by the Applicant to be, by and large, inaccurate if not totally misleading. Applicant's U.S. patent No. 6,584,855 discloses and discusses a unique apparatus and method for measuring building pressure by understanding the relation of exterior pressure forces and other variables on the "skin" of the building and also on the resulting internal building pressure. Nonetheless, a myriad of

additional misconceptions concerning internal building pressure have yet to b addressed by the prior art

One of the tasks of building maintenance personnel, building designers, building automatic control systems and building owners, is to properly control the internal temperature, humidity and air pressure of a building. Ideally, the internal air pressure of a building should be at equilibrium, and therefore, uniform between all of the floors, ceilings, walls, ceiling cavities, floor cavities and wall cavities, as well as all open areas, rooms and other interstitial areas of a building, so as to prevent the transmission of odors, gases, contaminants, or even humidity and temperatures, between the many floors of a multiple floor building. In other situations, internal building pressure control is critical for explosion and corrosion control and for protection during outdoor airborne biological, radiological, and chemical events and attacks.

A prevalent misconception exists that the only dynamic events that occur within the core of a building are temperature and/or elevator shaft related. The prior art has mistakenly thought that "chimney effect", "warm air rising", "buoyancy of air" or other scientific and not so scientific effects were the primary reasons that made buildings with more than one floor more difficult to temperature and humidity control. Others in the prior art have mistakenly thought that building elevator shafts caused pressure anomalies between the various floors of the building due to a "plunger" type of effect caused by the moving elevators.

While thes explanations sound reasonable, Applicant has determined that they are incorrect. In fact, th se explanations sound so reasonable and these effects seem so "uncontrollable", and the experts in the field considered these temperature and elevator related explanations so satisfactory, that the observed problems have simply been ignored and left unsolved for the past one hundred years.

Applicant has determined that elevators and elevator shafts do not combine to create an effective "plunger" effect and that warm air rising does not actually produce enough force to move much air easily between concrete floors, for example. Applicant has determined, instead, that the ever varying and dynamic pressure relationships between the various floors of a multiple floor building, generated by many variables over the height of the building, is the primary reason that buildings with more than one floor are difficult to temperature and humidity control. It is these pressure differences that can pull germs, for example only, from a third floor patient room and cause them to precipitate out on the tenth floor, thus uncontrollably spreading germs throughout a hospital. Thus, there is a need in the art for providing an apparatus and method which provides dynamic, responsive control of internal building pressure in buildings with more than one floor. It, therefore, is an object of this invention to provide an internal building pressure apparatus and method for obtaining the pressure relationships between the floors of a building with more than one floor and thereafter regulating the pressures as

circumstances and individual needs require. Such apparatus and method must be able to account for any variable and arrive at an accurate pressure relationship for the individual floors of a building.

SUMMARY OF THE INVENTION

An internal building pressure apparatus and method of the present invention includes, in a building with walls and more than one floor, at least one pressure sensor per floor. A connection is provided for connecting the pressure sensors and an analysis device is connected to the pressure sensors for receiving input from the pressure sensors and for providing sensor data output.

According to another embodiment of the invention, a controller is connected to the analysis device wherein the controller regulates internal pressure on at least two or more of the floors and possibly all of the floors of a building. According to a further embodiment, the building includes multiple floors and the analysis device provides sensor data output from a group of outputs including sensor data output from adjacent floors and sensor data output from non-adjacent floors. According to a further aspect of the invention, the sensor data output includes output from a group including maximum pressure, minimum pressure, average pressure and any pressure in between maximum and minimum for a particular floor and the building as a whole. According to another aspect of the invention, at least one pressure

sensor outside of the building is provided and the sensor data output includes output from a group including total internal building pressure and outside pressure, and/or the internal pressure of a particular floor and outside pressure or a portion of a particular floor and outside pressure.

According to further aspects of the invention, sensor data output includes output from a group including within wall pressure only and between floor pressure only. A further aspect of the invention includes a plurality of pressure sensors per floor. Another aspect of the invention includes pressure sensors placed in locations selected from a group of locations including open rooms, closed rooms, foyers, corridors, wall cavities, floor cavities, ceiling cavities, on walls, on ceilings, and on floors and any other interstitial area of the building.

According to another embodiment of the invention, in a building with walls and multiple floors, an internal building pressure apparatus includes at least one pressure sensor on at least more than one of the multiple floors. A connector connects the pressure sensors and an analyzer is connected to the pressure sensors for receiving input from the pressure sensors and for providing pressure sensor data output. According to another aspect of the invention, a controller is connected to the analyzer for controlling the pressure in the building in response to sensor data output from the analyzer. Other aspects of this invention are more fully disclosed hereafter.

According to a further mbodiment of the invention, in a building with walls and multiple floors, a method of controlling internal building pressure includes the steps of providing at least one pressure sensor on at least more than one of the multiple floors. The pressure sensors are connected and an analyzer is attached to the pressure sensors for receiving input from the sensors and for providing sensor data output. According to a further aspect of the invention, a controller is attached to the analyzer and controls the pressure in the building in response to sensor data output from the analyzer. Other aspects of the method of invention according to further aspects of the invention are more fully disclosed hereafter.

DESCRIPTION OF THE DRAWINGS

FIGURE 1 is a top view of the present invention according to one embodiment illustrating the placement of pressure sensors about a generally symmetrical floor;

FIGURE 2 is a plan view of the embodiment of Figure 1 illustrating the placement of pressure sensors between adjacent floors;

FIGURE 3 is a plan view of the embodiment of Figure 1 illustrating the placement of pressure sensors between non-adjacent floors;

FIGURE 4 is a schematic diagram of an analysis and connection system for analyzing and connecting separate pressur sensors of the embodiment of Figure 1; and

FIGURE 5 is a schematic diagram of a control system for receiving and manipulating sensor data and controlling pressure within a building according to the embodiment of Figure 1 of the invention.

DETAILED DESCRIPTION OF THE INVENTION

An embodiment of the present invention is illustrated by way of example in Figures 1-5. With specific reference to Figures 1-3, the internal building pressure apparatus 10 according to one embodiment of the present invention includes, in a building 12 with floors 44 and walls 46, at least one pressure sensor 18 on more than one of the multiple floors. This is to say that pressure sensors 18 may be on every floor44 of a multiple floor building 12 or every other floor44 or any combination of floors 44 desired. The location of pressure sensors 18 on one particular floor 44 need not match the location or quantity of pressure sensors 18 on any other floor 44. Any pressure sensor 18 location that is desired or appropriate may be used. As used herein the term "floor" 44 includes any combination of floor surfaces 45, walls 46 and ceilings 42, forming a closed 56 or open 54 space within a building 12.

For clarity, connection tubes 22 and connection wiring 24 that run back to an analyzer 26 and/or controller 32, as discussed more fully hereafter, hav been purposefully left off of Figures 1-3. Refer to Figures 4 and 5 for additional details of connections 20, 22 and 24.

According to one embodiment, pressure sensor 18 is placed in a location selected from a group including within walls 46 and between floors 44. As will become more fully apparent hereafter, any pressure sensor 18 location that is desired or appropriate to the invention may be used. Within wall location, wall cavity, 52 may be any location within the wall 46 desired and/or appropriate. Between floor location, floor cavity, 50 likewise may be any between floor location 50 that is desired and/or appropriate. For example only, and not by way of limitation, any interstitial area of a building 12, such as a ceiling cavity 48, may also be a location for pressure sensor 18. Also, open rooms 54, closed rooms 56, foyers 58, corridors 60, and on walls 46, on floor surfaces 45 and ceilings 42 are examples of pressure sensor 18 locations.

Pressure sensors 18 are connected by connection 20, as will be disclosed more fully hereafter. Nonetheless, connection 20 may be any connection now known or hereafter created including connection tubing 22, connection wiring 24, or wireless connections, such as infrared, lasers and the like (not shown) as is well-known in the art and not disclosed more fully hereafter. According to the

invention, connections 20 may be between each and every pressure sensor 18 or any selected group of pressur sensors 18 as desired.

An analysis device 26 is connected to the pressure sensors 18 for receiving input from the pressure sensors 18 and for providing sensor data output as will be disclosed more fully hereafter. Analysis device 26 may be any device now known or hereafter developed for receiving pressure sensor data input from the pressure sensors 18 and for providing sensor data output in a form useful to the user. It should be understood that pressure sensor 18 may include as an integral part an analysis device 26 in the case where the pressure sensor 18 itself produces an electrical or electronic measurement and output.

Figure 1 most clearly illustrates the location of pressure sensors 18 within wall cavity location 52 as seen from the top of building 12. As illustrated, in Figure 2, building 12 includes multiple floors 44 and Figure 1 is a top view of only a single floor 44. Figure 2 most clearly illustrates floor cavity locations 50 for pressure sensors 18. Pressure sensors 18 may also be placed on the outside 14 of a building 12 as and if desired. Once pressure sensors 18 are added to this additional area, comparisons can be made between the interior/internal pressure of building 12 as determined by pressure sensors 18 within walls 46 and between floors 44 and the pressure on the outside 14 of building 12. Still further, pressure sensors 18 may also be placed on the interior of walls 46 and on the visible floor surfaces 45 and/or ceilings 42 for additional pressure comparison points.

Referring now to Figure 3, connections 20 are shown such that pressure sensors 18 are connected so as to enable analysis device 26 and/or control system 32 to obtain pressure information from non-adjacent floors 44. Figure 2 illustrates the ability of connections 20 and analysis device 26 to provide pressure comparisons from pressure sensors 18 located on adjacent floors 44. Certainly any combination of adjacent and non-adjacent floor sensor comparisons are provided in accordance with the invention disclosed herein.

By way of a more complete description, the combinations of connections 20 and pressure sensors 18 and the variety of possible locations for pressure sensors 18 within walls 46 and between floors 44, as well as other desirable locations, are many indeed. That is to say, as illustrated in Figures 1-3, the various connections enable analysis device 26 and/or computer control system 32 to provide sensor data output from a group of outputs including sensor data output from adjacent floors 44 and sensor data output from non-adjacent floors 44. Still further, sensor data output includes output from a group including maximum pressure, minimum pressure, average pressure and pressure in-between maximum and minimum, for a particular floor 44 and for the building 12 as a whole.

Still further, when at least one pressure sensor 18 is provided on the outside 14 of building 12, sensor data output includes output from a group including total internal building pressure and pressure on the outside 14 of a building 12 and/or the int rnal pressure of a particular floor 44 or portion of a particular floor 44 and

pressure on the outside 14 of building 12. Still further, obviously, sensor data output includes output from a group including within wall cavity 52 pressure only and between floor cavity 50 pressure only.

Referring now to Figure 4, the individual pressure sensors 18 are shown connected by connections 20, either connection tubing 22 and/or connection wiring 24, or, again, any wireless connection now known or hereafter developed, to analysis device 26. Additionally, pressure sensors 18 are shown connected by connections 20, of any type, to each other so as to enable analysis and manipulation of pressure sensor data from any and every pressure sensor 18 alone or in any combination.

Analysis device 26 includes hardware 28/software 30. Hardware 28/software 30 is any such hardware 28 or software 30 or combination thereof now known or hereafter developed for receiving pressure sensor 18 input from pressure sensors 18 and converting it to usable sensor output. Such output may be any now known or hereafter desired, including pressure gauges, analog and/or digital read outs, images and the like. Pressure sensors 18 may also capture and transmit for analysis any other relevant data such as temperature, humidity and the like.

Referring now to Figure 5, according to one embodiment of the invention, a control system 32 is connected to analysis device 26 or directly to pressure sensor 18 via connection 24. Control system 32 may be any control system now known

or hereafter developed such as, but not limited to, for example, a CPU 34 and associated well-known elements such as monitor 36, keyboard 38, and mouse 40. Any of the well-known substitutes for one or all of these particular items is included within the scope of the invention. Control system 32 utilizes hardware 28/software 30 for the assimilation and manipulation of sensor data output from analysis device 32. By way of example only and not by limitation, computer control system ("controller") 32 receives sensor data output from analysis device 26, or directly from pressure sensors 18 via connection 24, for example, and regulates the internal pressure of building 12 in accordance with the user's desires. The user may, for example only and not by limitation, desire that the building 12 internal pressure be positive on each and every floor 44 of building 12. By comparing the internal pressure data with pressure on the outside 14 of building 12, a positive internal pressure may be maintained. A positive internal pressure of building 12 , for example, ensures that no external contaminants are allowed to infiltrate building 12.

In another example, the user may desire to maintain all of the individual floors 44 at the same pressure to each other, regardless of the pressure relationship to outdoors 14. In both of these examples, the user has the similar goal of maintaining internal equilibrium between all floors 44 and to restrict air movement between floors 44.

On the other hand, by way of example again only, a negative internal pr ssure within the building 12 or within a particular floor 44 of building 12 may be desired as well. Still further, the user may desire to maintain one or more floors 44 at a different pressure(either higher or lower) in relationship to surrounding floors 44, so as to isolate these floors 44 from the other floors 44 so as to prevent air from escaping or entering the floors 44. In sum, control system 32 in combination with other well-known heating, cooling and air-conditioning devices controls and manipulates the internal pressure of building 12 in any manner desired by the user.

The method for measuring and maintaining the pressure relationships between the floors 44 of buildings 12 with more than one floor 44 of the present invention includes the steps as previously disclosed and discussed above. The method is relatively simple to implement and execute. The steps, according to one embodiment, include attaching at least one pressure sensor 18 on at least more than one floor 44 of a multiple floor building 12 at any desired location. Pressure sensors 18 are connected by connections 24 and/or 22 as discussed above such that more than one measurement can be taken between floors 44 to produce additional, or more accurate, or averaged, information. That is to say, the pressure measurements can be made between multiple floors 44, and at multiple locations on each floor 44 and within open rooms 54 and corridors 60 of the individual floors 44, as well as on the walls 46, floor surfaces 45 and ceilings 42 as discussed above. Also, as a user desires, pressure sensors 18 may be placed

within any interstitial spaces, cavities, of building 12 including, but not limited to, wall cavity 52, floor cavity 50 and ceiling cavity 48 as well as on the outside 14 of the building 12. Obviously, the sensor 18 arrangement for one floor 44 and/or wall 46, need not match the pressure sensor 18 arrangement of the any other floor 44 or wall 46. Analysis device 26, whether in combination with control system 32 or not, allows the user to relate the pressure of any one floor 44 to that of another or to the building 12 as a whole in any number of useful schemes.

It should be understood that the term "sensor" as used herein applies to all known or newly discovered "pressure sensors". Certainly a wide variety of known pressure sensors 18 can be used to employ this present invention. Some pressure sensors 18, as now known, have the ability to produce an electrical/electronic, pressure measurement. This pressure measurement is the pressure sensor output as discussed herein which can be electrically/electronically relayed to analysis device 26 and/or control system 32 as desired. Other pressure sensors18 may simply communicate a pressure via a tube/conduit to a device that can then produce a measurement, that can then be relayed to analysis device 26 and/or control system 32 as desired.

The description of the present embodiments of the invention has been presented for the purposes of the illustration, but is not intended to be exhaustive or to limit the invention to the form disclosed. Many modifications and variations will be apparent to those of ordinary skill in the art. As such, while th present

invention has been disclosed in connection with the preferred embodiment thereof, it should be understood that there may be other embodiments which fall within the spirit in scope of the invention as defined by the following claims.